Space Weather Technical Forecast

Issued on Friday, 18 February 2022 at 12:33 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor geomagnetic storm intervals Likely in to new week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with isolated low-level C-class flares observed. These were mainly spawned from two areas of the sun, firstly a region narrowly over the northwestern horizon, perhaps Ex-2941, but the largest event came from AR2950, an Axx/Alpha which managed a C1.4 at 17/2051UTC.

The past 24 hours saw a sharp reduction in sunspot count, with all of the western solar hemisphere groups fading to plage or pores, leaving a sparse and mainly unipolar eastern solar hemisphere. These spots included the aforementioned AR2950 as well as newly-numbered 2952 as Axx/Alpha groups. The most complex region lay nearer centre disc in the form of AR2948, which saw some slight consolidation and presented as Cso/Beta by the end of the period.

No Earth-directed Coronal Mass Ejections (CMEs) were in evidence in available coronagraph imagery in the past 24 hours, with the main feature on coronagraphs being a rear-westward CME. There is some evidence to suggest a minor filament may have been ejected concurrently with the long-period flare from AR2950, however this is very faint on coronagraphs - if even attributable to this event - and directed above the ecliptic plane (to no effect at Earth).

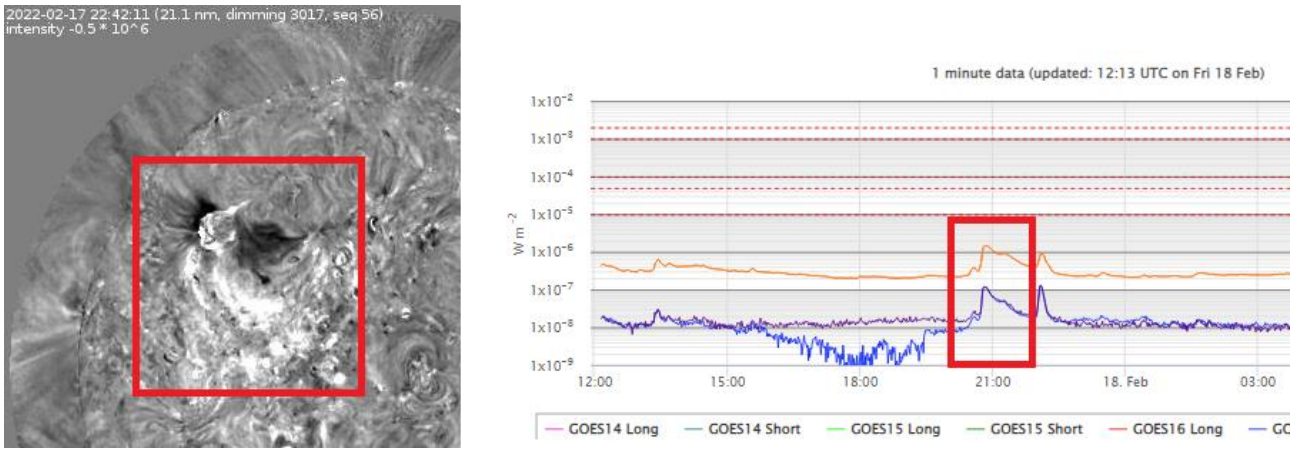

Figure 0: Left: Time-integrated view in AIA 211 of dimming from near AR2950 tied to a small, long-period C-class flare in the sun's northeastern quadrant in the period (image processing courtesy of SIDC ROB). Right: GOES 16 X-ray flux, showing related flare. Any resultant CME is not thought to have an Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was characterised by a slow regime, but with a rising trend in most measures. The cause of this is uncertain, but may be related to a close pass by a minor transient or perhaps an impending solar

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sector crossing, for lack of any forecast coronal hole high speed streams.

The solar wind speed was stable within typical background levels of between 325 and 350km/s in the period, however the solar wind density displayed a rise from mid-single figures ppcc to peak just shy of 20ppcc. There was also a slight enhancement in ACE EPAM LEMS in the period, which may perhaps indicate a possible transient, with this possibly in course recently at STEREO A according to MAG and PLASTIC data here, although this is conjectural. The IMF rose in magnitude over the same interval, peaking at 8nT before stablising later in the UTC morning of Friday. The north-south component ranged between +6 and -5nT, while the phi angle was negative (towards the sun) throughout.

The net result of the above solar wind measures was provisionally Quiet Kp indices throughout - at or below Kp 1+.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels since around 12 hours after an evidently very large and energetic flare and CME seen on coronagraph imagery from the rearward eastern solar hemisphere on 15 February. This has plateaued near 1pfu and is unlikely to increase further (in the absence of further such events). The 50MeV and 100MeV traces are unmoved from Background.

The high energy electron flux (greater than 2MeV) was at Normal Background to Moderate levels, with a diurnal peak narrowly in High flux at 1460pfu at 18/1120UTC. The corresponding 24-hour integrated electron fluence declined and then plateaued, dropping below the 1e8 Active level at 17/1800UTC, and with a reading of 3.86e7 integrated pfu recorded at 18/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low or Very Low at first, given the sparsely populated Earth-facing disc, however there are indications that a large and potent region may rotate onto the facing side into the new working week. The magnitude of this increase will be assessed as and when the spot responsible becomes visible to analyse.

Solar Wind / Geomagnetic Activity: No CMEs feature in this forecast period.

Solar winds should remain in a slow regime until the possible onset of coronal hole 55 and then 56 in succession over the second half of the four-day period, giving Likely G1 Minor Storm intervals on Sunday 20 February, and a Chance of continuation on Monday, else being largely Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux is expected to remain within Background levels during the period, with the very slightly disturbed 10MeV trace relaxing through the period.

High energy electron flux is expected to remain below the High threshold (1000 pfu) for most of the time, but with a rising chance of more lasting exceedence by the very end of the four days after the onset of both coronal holes. The corresponding electron fluence is expected to remain below the Active (>1e8 integrated pfu) electron fluence threshold, but with a rising probability late in the four days, and Likely exceedence beyond the current four-day period - once coronal hole geomagnetic activity wanes.

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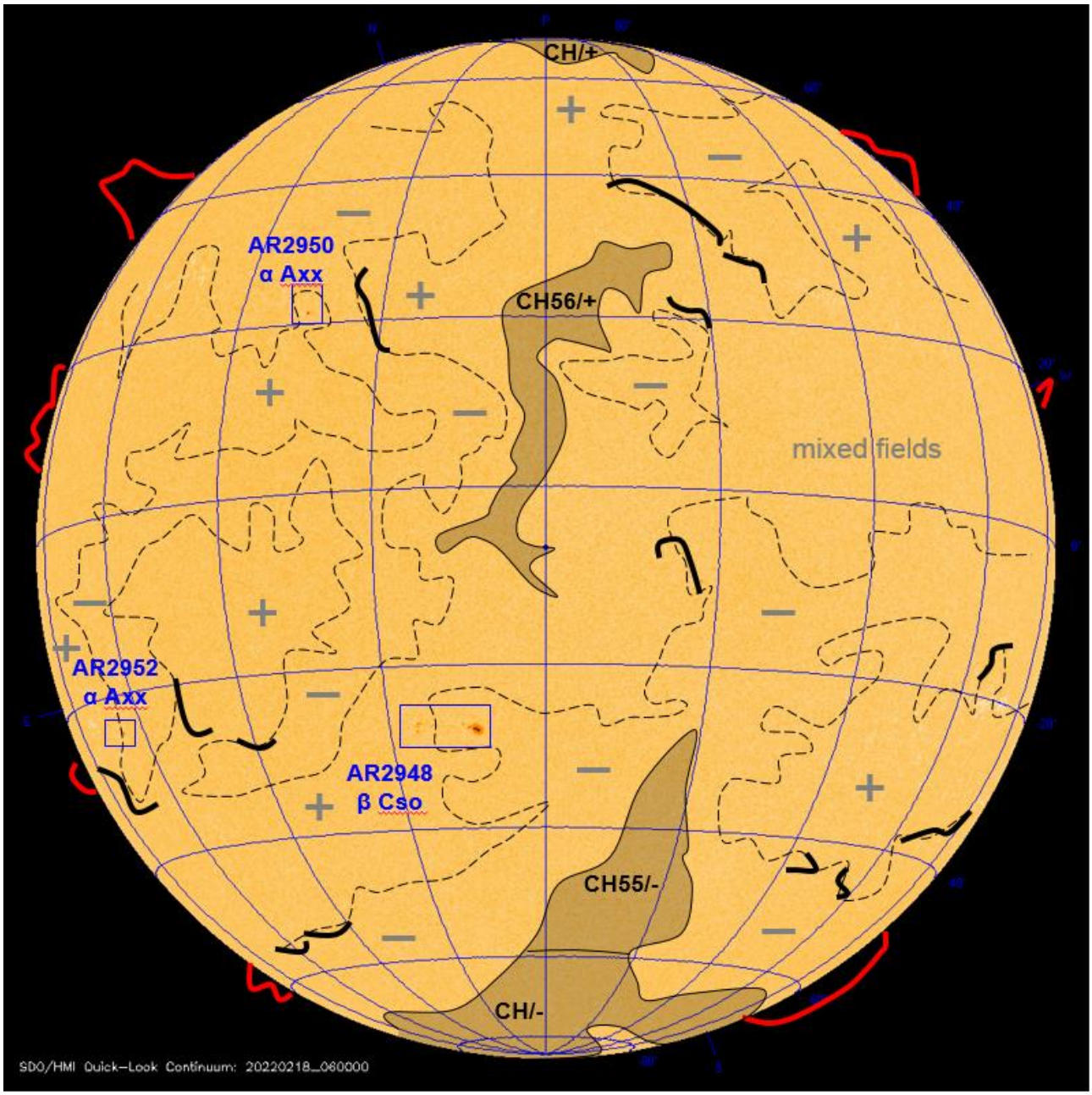
Figure 1. Solar Analysis Valid 18/0600UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in this forecast at present.

Current Quiet solar wind conditions are expected to increase over the second half of the four days as a result of a pair of coronal hole high speed streams. These are of opposing polarity, and any transition between them should be distinct. Of the pair, the earlier-arriving ought to be the more impactful, for being of more potent negative polarity (near the vernal equinox).

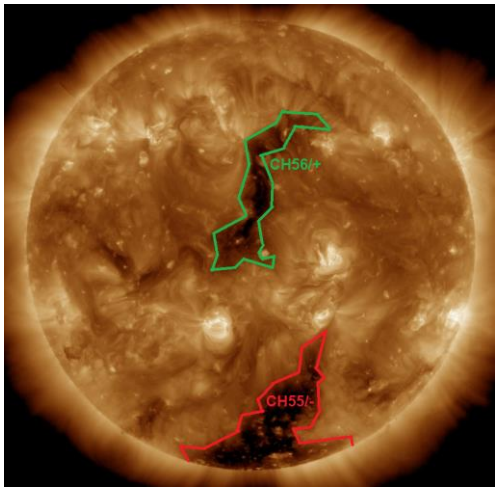
After around 24 hours, the phi angle may switch to positive, with effects from CH56/+ probably more muted, although this coronal hole combined with any belated activity from CH55/- should serve to prolong the risk of G1.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	60	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: AIA 193 image from 18/1200UTC, showing relevant forecast coronal holes due later in the four-day period. The southernmost is expected to be of greater magnitude owing to its polarity and being polar-connected.



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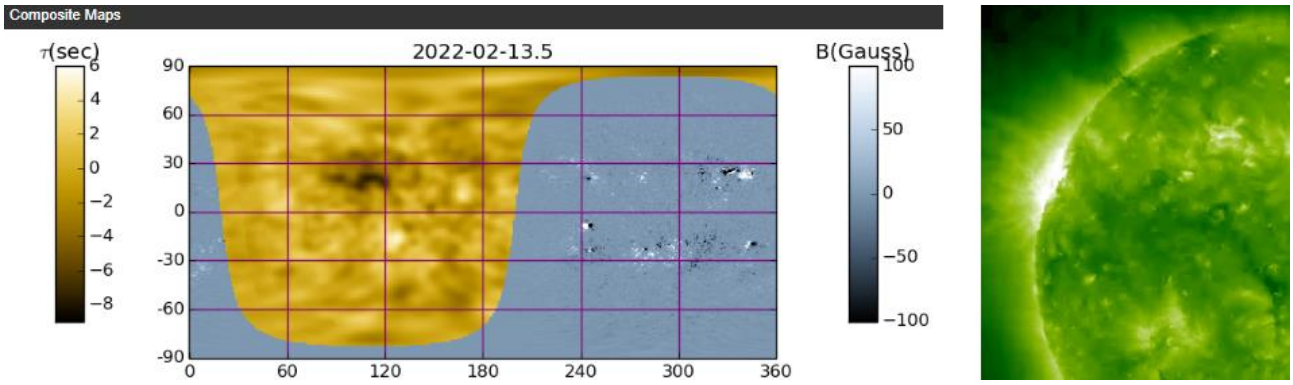
Radio Blackouts - X-Ray Flares:

The solar disc has greatly simplified in the past 24 hours, with the western solar hemisphere seeing all its spots fade, while those in the east remained relatively quiet and unremarkable.

Barring any front-sided development, the most significant event likely in the period is the possible return of the region of the sun responsible for the large rearward flare and CME on 15 February, with a fountain of ejecta visible out to half a solar radius in EUVI304. The region responsible may now just be becoming visible on STEREO A EUVI195 imagery, however any upward contribution it makes to the current Slight daily Chance of M-class flares will be assessed when it arrives over the limb. None of the remaining front side spots should leave the disc in the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Left: Far side soundings of a large region (shown as the dark area near 120E), thought to be that responsible for an impressive off-ecliptic flare and CME seen in coronagraphs late on 15 February. This region is now on STEREO A's eastern horizon and appears intense, if comparatively inactive in the intervening few days.



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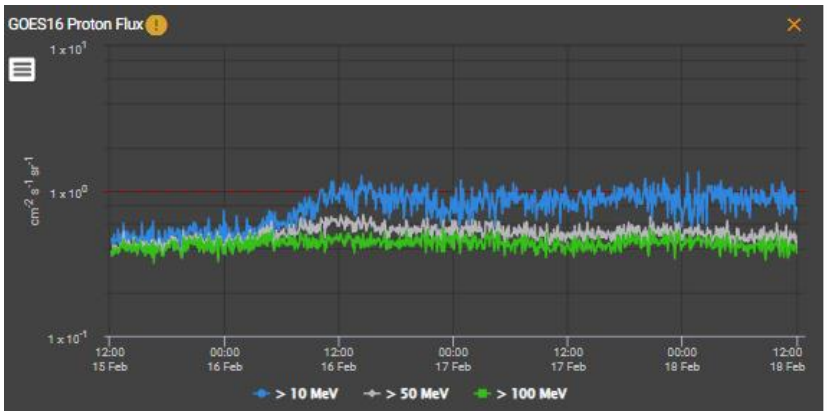
Solar Radiation Storms - (High Energy Protons):

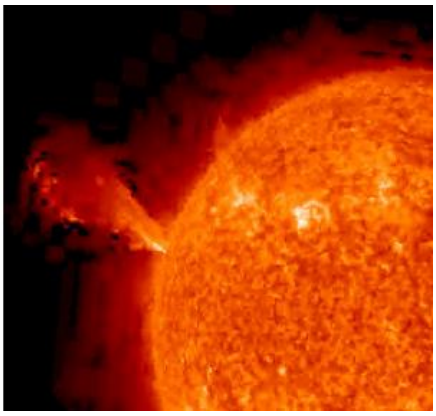
The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels since around 12 hours after an evidently very large and energetic flare and CME seen on coronagraph imagery from the rearward eastern solar hemisphere on 15 February. This region has not produced noteworthy events since, and is moving further from being geoeffective, so while S1 enhancements are not expected, it provides indication of something to watch should it survive into the new week to return to the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES 16 high energy proton flux for the past 72 hours, with the 10MeV graph showing a delayed but subsequently lasting response from unusually far eastward on the sun – from which we can infer that the event shown in EUVI304 (right) was particualrly energetic.





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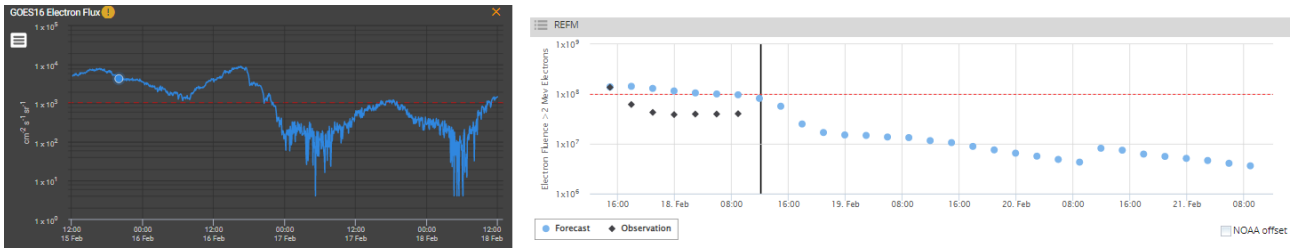
High Energy Electrons Event (≥ 2MeV):

High energy electron flux is expected to follow a similar diurnal trend to that seen at present into the UTC weekend in the absence of any expected external drivers. This is likely to respond upwards in the wake of geomagnetic activity from coronal holes 55 and 56, with much of any rise likely outside of the coming four days.

REFM's largely flat indicated trend is supportive of this initial idea, with any uptick outside its three-day forecast range.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	40	20	10	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES 16 high energy electron flux from the past three days, showing a now similar magnitude diurnal oscillation has been reached. This is likely to continue in the short-term, as indicated by REFM until the onset of a pair of coronal holes, with the first probably due by the end of the UTC weekend (not shown).



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